CLAIMS

What is claimed is:

1. An apparatus, comprising:

a photonic crystal lattice in first semiconductor material, the first semiconductor material having a plurality of holes defined in the first semiconductor material, the plurality of holes periodically arranged in the first semiconductor material with a hole pitch and a hole radius to define the photonic crystal lattice;

second semiconductor material regions disposed proximate to and insulated from respective inside surfaces of the plurality of holes defined in the first semiconductor material;

charge modulated regions to be modulated in the second semiconductor material regions, wherein an optical beam directed through the photonic crystal lattice is modulated in response to a modulated effective photonic band gap of the photonic crystal lattice, the effective photonic band gap modulated in response to the charge modulated regions.

2. The apparatus of claim 1 wherein the effective photonic band gap of the photonic crystal lattice is modulated in response to a refractive index in the second semiconductor material that is modulated in response to the charge modulated regions.

3. The apparatus of claim 1 wherein the effective photonic band gap of the photonic crystal lattice is modulated in response to an effective hole radius of each of the plurality of holes that is modulated in response to the charge modulated regions.

4. The apparatus of claim 1 wherein the optical beam has a plurality of wavelengths including a first wavelength and a second wavelength, wherein one of the first and second wavelengths of the optical beam is allowed selectively to propagate through the photonic crystal lattice at a time in response to the modulated effective photonic band gap of the photonic crystal lattice.

5. The apparatus of claim 1 wherein a voltage signal is coupled to be applied to the second semiconductor material regions relative to the first semiconductor material to induce the charge modulated regions to modulate the effective photonic band gap of the photonic crystal lattice.

6. The apparatus of claim 1 wherein a current signal is coupled to be injected through the second semiconductor material regions to induce the charge modulated regions to modulate the effective photonic band gap of the photonic crystal lattice.

7. The apparatus of claim 1 further comprising insulating material disposed between the second semiconductor material regions and the first semiconductor material to insulate each respective second semiconductor material region from the first semiconductor material.

8. The apparatus of claim 1 wherein the first and second semiconductor materials include silicon.

9. The apparatus of claim 8 wherein the first semiconductor material includes crystal silicon and the second semiconductor material includes polysilicon.

10. The apparatus of claim 1 wherein each of the plurality of holes is filled with material having an index of refraction that is substantially different than an index of refraction of the first semiconductor material.

11. The apparatus of claim 1 wherein capacitive structures are defined by the second semiconductor material regions insulated from the first semiconductor material.

12. The apparatus of claim 1 further comprising an optical waveguide included in the first semiconductor material through the

photonic crystal lattice, the optical beam to be directed through the optical waveguide and through the photonic crystal lattice.

13. A method, comprising:

directing an optical beam through a photonic crystal lattice in first semiconductor material, the first semiconductor material having a plurality of holes defined in the first semiconductor material, the plurality of holes periodically arranged in the first semiconductor material with a hole pitch and a hole radius to define the photonic crystal lattice;

modulating charge concentrations in charge modulated regions in second semiconductor material regions disposed proximate to and insulated from respective inside surfaces of the plurality of holes defined in the first semiconductor material;

modulating an effective photonic band gap of the photonic crystal lattice in response to the modulated charge concentrations; and

modulating the optical beam directed through the photonic crystal lattice in response to the modulated effective band gap.

14. The method of claim 13 further comprising modulating a refractive index in the second semiconductor material in response to modulating the charge concentrations in the charge modulated regions in the second semiconductor material regions.

15. The method of claim 13 further comprising modulating an effective hole radius of each of the plurality of holes in response to modulating the charge concentrations in the charge modulated regions in the second semiconductor material regions.

16. The method of claim 13 wherein modulating the optical beam directed through the photonic crystal lattice comprises selectively blocking one wavelength of the optical beam from propagating through the photonic crystal lattice in response to the modulated effective band gap of the photonic crystal lattice.

17. The method of claim 16 further comprising allowing another wavelength of the optical beam to propagate through the photonic crystal lattice while selectively blocking the one wavelength of the optical beam from propagating through the photonic crystal lattice in response to the modulated effective band gap of the photonic crystal lattice.

18. The method of claim 13 wherein modulating charge concentrations in the charge modulated regions the in second semiconductor material regions comprises modulating a voltage signal applied to the second semiconductor material regions relative to the first semiconductor material.

19. The method of claim 13 wherein modulating charge concentrations in the charge modulated regions the in second semiconductor material regions comprises modulating a current signal injected through the second semiconductor material regions.

20. A system, comprising:

an optical transmitter to transmit an optical beam;

an optical receiver; and

an optical device optically coupled between the optical transmitter and the optical receiver, the optical device including:

a photonic crystal lattice in first semiconductor material, the first semiconductor material having a plurality of holes defined in the first semiconductor material, the plurality of holes periodically arranged in the first semiconductor material with a hole pitch and a hole radius to define the photonic crystal lattice;

second semiconductor material regions disposed proximate to and insulated from respective inside surfaces of the plurality of holes defined in the first semiconductor material; and

charge modulated regions to be modulated in the second semiconductor material regions, the optical beam received from the optical transmitter and directed through the photonic crystal lattice, the optical beam modulated in response to a modulated effective photonic band gap of the photonic crystal lattice, the effective

photonic band gap modulated in response to the charge modulated regions, wherein the modulated optical beam is received by the optical receiver.

21. The system of claim 20 wherein the effective photonic band gap of the photonic crystal lattice is modulated in response to a refractive index in the second semiconductor material that is modulated in response to the charge modulated regions.

22. The system of claim 20 wherein the effective photonic band gap of the photonic crystal lattice is modulated in response to an effective hole radius of each of the plurality of holes that is modulated in response to the charge modulated regions.

23. The system of claim 20 wherein the optical beam has a plurality of wavelengths including a first wavelength and a second wavelength, wherein one of the first and second wavelengths of the optical beam is allowed selectively to propagate through the photonic crystal lattice at a time in response to the modulated effective photonic band gap of the photonic crystal lattice.

24. The system of claim 20 wherein the optical device is coupled to receive a voltage signal to be applied to the second semiconductor material

regions relative to the first semiconductor material to induce the charge modulated regions to modulate the effective photonic band gap of the photonic crystal lattice.

25. The system of claim 20 wherein the optical device is coupled to receive a current signal to be injected through the second semiconductor material regions to induce the charge modulated regions to modulate the effective photonic band gap of the photonic crystal lattice.

26. The system of claim 20 wherein the optical device further includes insulating material disposed between the second semiconductor material regions and the first semiconductor material to insulate each respective second semiconductor material region from the first semiconductor material.

27. The system of claim 20 wherein each of the plurality of holes is filled with material having an index of refraction that is substantially different than an index of refraction of the first semiconductor material.

28. The system of claim 20 wherein capacitive structures are defined by the second semiconductor material regions insulated from the first semiconductor material.